

ABSTRACT

Effect of organic surface functionalization on the electronic and magnetic properties of ultrathin gold films

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Chemisorption of self-assembled monolayers, specifically alkanethiolates on gold, strongly modifies the electronic properties of the Au surface. For a sufficiently thin Au film, this modification can be detected via the Au electrical resistance, and previous work has suggested detection limits of 1×10^{-5} of a monolayer are possible with resistivity measurements. Moreover, recent reports suggest that the Au-thiol interface has novel magnetic properties as well, with a paramagnetic interface moment dominating the normal bulk Au diamagnetism. In 2 nm nanoparticles, thiol chemisorption leads to a permanent magnetic moment which is present at room temperature, suggestive of enormous anisotropy energies. However, all measurements of Au-thiol magnetism to date have been reported with SQUID magnetometry, and depend heavily on proper background subtraction. To confirm these novel magnetic properties, we have measured the magnetoresistance (Planar Hall Effect) in a thin (20 nm) Co film underlying a 20 nm Au film to detect changes induced by thiol self-assembly. Our results confirm a coupling between the chemisorption process and the magnetic properties of the Co film. However, due to large sample-sample variability, we cannot yet estimate the interface moment of the Au-thiol. In addition to the magnetotransport properties of Co/Au bilayers, we have recently demonstrated that electrical resistance can detect the hybridization of DNA attached to a thin Au film. Here a $\sim 5\%$ change in the resistance occurs when a single stranded oligonucleotide is matched with its complementary strand. These results suggest that combined electronic/magneto transport offers a highly sensitive approach to detecting changes in chemically-functionalized surfaces, with broad potential application to military and medical sensing.